Behaviour of Clayey Soil Mixed With Randomly Distributed Rubber Tyre Waste

Rajib Ghosh, Joyanta Maity

***Abstract*— Large construction of various Civil Engineering schemes demands optimum and efficient use of construction resources. Requirement of fill material for large-scale constructional activities of roads, is enormous and available soils near construction sites are weak in strength and of high compressibility. This type of low strength soils need addition of some strengthening elements to increase their strength and reduce their high compressible nature. On the other hand, the uses of motor vehicles are increasing in everywhere in an extreme rate. The application of waste rubber tyre in soil results increase in strength and decrease of deformability. Such application will reduce the cost by providing lesser thickness of pavement results lesser quantity of materials.**

In this paper waste rubber tyre has been randomly mixed at varying length and percentage with weak clayey soil to improve the strength and decrease the deformability of soil. Standard Proctor test and California Bearing Ratio test have been conducted for each combination of soil- rubber tyre chips mix combination to study the behaviour of the engineering properties of soil- rubber tyre chips mix combination. From the test results, it was observed that with the increase in percentage of waste tyre chips in soils, maximum dry density decreases whereas optimum moisture content remains almost constant. Further, the CBR value of the soil- rubber tyre chips mix composite at OMC, increased with increase in percentage of waste tyre-tube chips.

***Index Terms*— Waste rubber tyre, deformability, Standard proctor test.**

I. INTRODUCTION

India is a developing country, it proposes multipurpose development projects. Large construction of roads, bridges, dams, irrigation schemes, public health engineering schemes, educational buildings and residential buildings etc. all these construction schemes demand optimum and efficient use of construction resources. Due to large-scale constructional activities of roads in India, requirement of fill material is enormous and available soils near construction sites are weak in strength and of high compressibility, even after proper compaction. Such soils need addition of some strengthening elements to increase the strength of weak soil. On the other hand, the uses of motor vehicles are increasing in everywhere in an unprecedented rate. Huge amount of scrap or waste rubber tyre constitute environmental and health hazards by producing air pollution from rubber tyre fires and breeding grounds for potential disease carrying mosquitoes and vermin. Also scrap tyre does not decompose easily. Disposal of waste rubber tyre are environmental dilemma. In this situation a safe waste rubber tyre disposal system is essential. The application of waste rubber tyre in soil results increase in strength and decrease of deformability. Such application will reduce the cost by providing lesser thickness of pavement results lesser quantity of materials. Making use of scrap tyres in subgrade improvement is not only a beneficial approach for reducing environmental pollution but also is economically efficient. Waste rubber tyres are light materials in road construction projects, fences behind the retaining walls, landfill drainage and thermal insulator. These rubber tyre materials have specific characteristics that enhance the quality of geotechnical projects. Their most noticeable characteristics are durability, strength, lightness, compaction, drainage, and high frictional resistance.

In this present study for the utilization of waste rubber tyre, a systematic experimental program is made on locally available weak clayey soil mixing with different percentages and sizes of waste rubber tyre.

II. PROPOSED INVESTIGATION

A. Materials Used

Natural Soil: The present investigation has been carried out on soil collected from local area of Habra, North 24 Parganas at a depth of 1.0 m below the ground surface (Fig.1). It is classified as CL as per IS classification. The properties of soil as tested in the laboratory are given in Table 1.

Figure 1: Natural soil

Figure 2: Waste rubber tyre

Waste Rubber Tyre: Waste rubber tyres are collected from the tyre recycling shop. These tyres are being cut into three different pieces of 4cm x 1cm, 2cm x 1cm and 1cm x 1cm. The thickness of tyre is varying from 0.1 to 0.9cm (Fig. 2).

Table 1: Physical properties of soil

Properties	Values
IS Classification	CL
Specific Gravity	2.3
Liquid Limit	31.23%
Plastic Limit	22.1%
Plasticity Index	9.13%
Gravel	0.44%
Clay	11%
Silt	86.84%
Sand	1.71%
Cu	8.5
Cc	1.89
Maximum Dry Density	1.742 gm/cc
Optimum Moisture Content	16.7%
CBR	4.8%

B. Test Programme

In this study to investigate the effect of inclusion of waste rubber tyre chips on compaction and strength characteristics of locally available clayey soil, standard Proctor test and unsoaked California Bearing Ratio test have been conducted for clayey soil mixed with randomly distributed waste rubber tyre chips of varying percentages of 1%, 3%, 5%, 7% & 9% and varying lengths of 1cm, 2cm, and 4cm. All the tests have been conducted as per relevant I.S. code provision

III. EXPERIMENT AND RESULT

Standard Proctor and unsoaked CBR test have been conducted in the laboratory as per I. S. Code provision, for different series of clayey soil (C)- waste rubber tyre (WRT) chips composite. The results of these tests are given in the table 2.

Table 2: Summary of result of standard proctor test

Description of mix	Size (cm)	MDD (gm/cc)	OMC (%)	CBR (%)
C	-	1.742	16.7	4.8
C+1% WRT	1cm x 4cm	1.71	16.41	7.97
C+3% WRT		1.698	15.8	9.37
C+5% WRT		1.653	16.2	7.92
C+7% WRT		1.630	16.4	6.08
C+9% WRT		1.612	16.5	5.34
C+1% WRT	1cm x 2cm	1.738	16.8	8.84
C+3% WRT		1.718	16.4	9.74
C+5% WRT		1.669	16.6	7.25
C+7% WRT		1.654	15.8	5.05
C+9% WRT		1.643	16.1	3.02
C+1% WRT	1cm x 1cm	1.737	16	6.11
C+3% WRT		1.702	16.4	7.54
C+5% WRT		1.671	15.8	5.43
C+7% WRT		1.632	16.4	3.21
C+9% WRT		1.620	16.6	2.65

A) Compaction characteristics:

The Standard Proctor tests have been conducted as per IS 2720 (Part-VII) on clayey soil- waste rubber tyre chips mix composites to determine the optimum moisture content (OMC) and maximum dry density (MDD). The clayey soil has been mixed with randomly distributed waste rubber tyre of varying percentages of 1%, 3%, 5%, 7% and 9% and varying lengths of 1cm, 2cm, and 4cm. The OMC and MDD values obtained from the standard Proctor test are given in table 2 and the variation of MDD and OMC with percentage of waste tyre tube chips are shown in fig. 3 and 4 respectively.

From these figures, it is observed that with the increase in percentage of waste rubber tyre chips, the MDD value of clayey soil- waste rubber tyre chips mix composites decreases whereas OMC value remain almost constant. The decrease in MDD is due to the light weight nature of rubber tyre in comparison with soil.

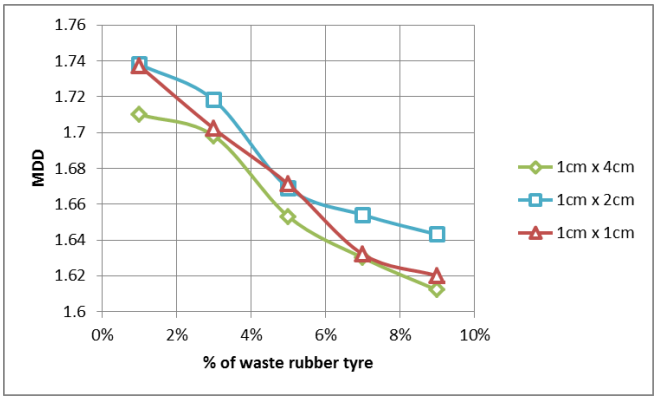

Figure 3: Variation of MDD with % of tyre chips

B) Strength characteristics:

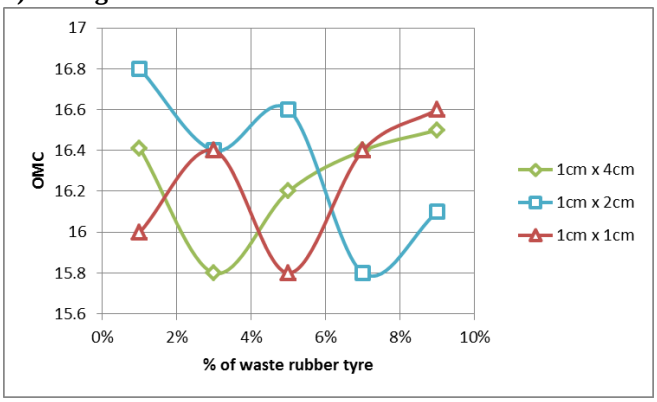

Figure 4: Variation of OMC with % of tyre chips

Unsoaked CBR tests have been conducted as per IS: 2720 (Part-XVI) on clayey soil- waste tyre-tube chips mix composites to evaluate the strength characteristics of soil stabilized with waste tyre-tube chips. Randomly distributed waste tyre-tube of varying percentages (1%, 3%, 5%, 7%, 9%)and sizes (4cm x 1cm, 2cm x 1cm and 1cm x 1cm) have been mixed with soil. The unsoaked CBR values obtained from the laboratory CBR test are given in table 2 and the variations of unsoaked CBR with percentage and length of tyre chips are shown fig. 5 and 6 respectively.

From the figures, it is observed that the unsoaked CBR values of clayey soil-tyre tube chips mix composite increases with increase of percentage as well as length of tyre tube chips and reaches a maximum value and after that it decreases slowly with further inclusion of waste tyre tube chips within the range of the testing programme. The maximum unsoaked CBR value of clayey soil obtained from the laboratory test is 9.74% for addition of 3% waste tyre tube chips size of 2cm x 1cm.

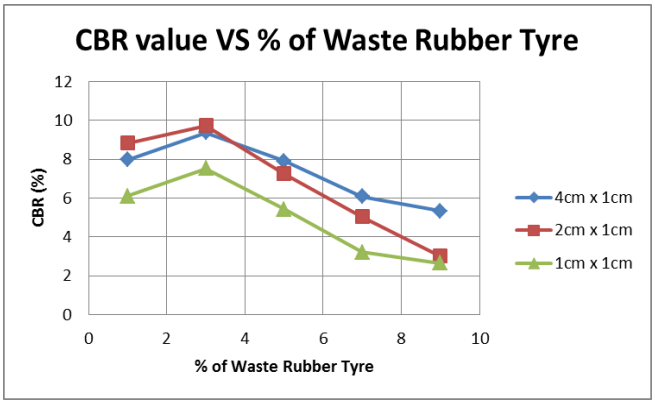

Figure 5: **Variation of unsoaked CBR with % of tyre chips**

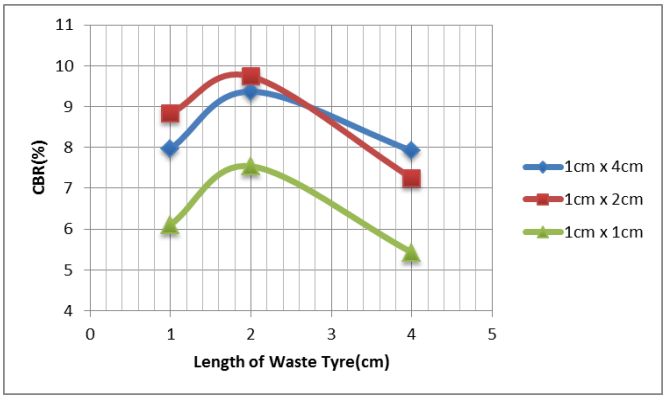

Figure 6: **Variation of CBR with length of tyre chips**

IV. CONCLUSION

Based on the experiments carried out on soil and soil- Tyre composite, the following observations and conclusions are drawn:

1) Maximum dry density of clayey soil-tyre tube chips mix composite decreases with the increase in percentage of waste rubber tyre chips. This is due to light weight nature of waste tyre-tube chips. On the other hand, the optimum moisture content almost constant with the increase in percentage of waste tyre-tube chips.
2) There is a considerable increase in the unsoaked CBR value for clayey soil due to mixing of randomly distributed waste tyre-tube chips. The maximum improvement in unsoaked CBR value is due to addition of waste tyre tube chips size of 2cm x 1cm. And optimum percentage of waste tyre tube chips is 3% of the dry weight of soil for all sizes of waste tyre chips used. Further the addition of waste tyre-tube chips to soils lead to a decrease in CBR values.

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